

# C-A OPERATIONS PROCEDURES MANUAL

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## **7.1.9 Compressor Room - Utility Compressor Operation**

### **1. Purpose**

This procedure covers the operation of the utility compressor skid. Evacuation and purging operations are strictly manual and must be carried out at the compressor skid. Other operations can be performed either manually at the local control panel or via the BNL computer. This OPM contains the following procedures relating to the operation of the compressor skid:

- |           |      |   |
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|           | 5.2  | Skid Initialization                             |
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### **2. Responsibilities**

- 2.1 The Shift Supervisor, or an Operator designated by the Shift Supervisor, is responsible for conducting this procedure and providing documentation in the Cryogenic Control Room.
- 2.2 Should a problem arise during the completion of this procedure, the Shift Supervisor shall contact the Technical Supervisor for instructions before continuing.

### **3. Prerequisites**

- 3.1 Operator shall be trained by the compressor room's cognizant engineer, and/or a person designated by the Operations Group Leader or Technical Supervisor, in the proper implementation of this procedure.
- 3.2 Operator shall become familiar with the first stage helium compressor P&ID 3A995021, and the physical location of components on the skid.

3.3 The skid is prepared as follows:

3.3.1 The compressor and oil pump have been checked for alignment and rotation, the skid has been leak checked, all instrument gas supply valves have been opened, and all electrical disconnects have been energized.

#### 4. **Precautions**

4.1 Lockout-Tagout procedures shall be used when servicing any component on the utility compressor skid.

#### 5. **Procedure**

##### 5.1 Emergency Shutdown

The utility compressor skid is outfitted with several safety interlocks and an emergency shutdown button mounted on the local control panel. When any of these devices are activated, the compressor and oil pump will automatically shut down, and the suction and discharge valves will close. If the system shuts down automatically, the local annunciator panel will light identifying which safety interlock activated the shut down.

- [1] In the event of an emergency depress the emergency shutdown button.
- [2] Immediately report to the shift supervisor for direction. Do not attempt to restart the compressor until all problems have been rectified. If the system has shut down because of a safety interlock, see section 5.11 for corrective action.

##### 5.2 Skid Initialization

This procedure is to configure and check out the utility compressor skid prior to being operated.

- \_\_\_\_\_ [1] Switch hand switch HS2399 into the "LOCAL" position.
- \_\_\_\_\_ [2] CONFIRM that all valves are in their initial positions according to the [C-A-OPM-ATT 7.1.9.a.](#)
- \_\_\_\_\_ [3] CONFIRM from log book that the system has been properly evacuated and backfilled with helium. If the system has not yet been evacuated, perform the evacuation procedures in accordance with section 5.5 of this OPM before proceeding.

- \_\_\_\_\_ [4] CONFIRM that the helium pressure in the skid is 30 psi (PI2381). If not, OPEN H2376A and use the purge return header valve H3044A to backfill the skid. When skid is at the correct pressure CLOSE both valves.
- \_\_\_\_\_ [5] CONFIRM both cooling water inlet and outlet valves are OPEN and adjusted for the proper flow. See [C-A-OPM 7.1.5](#), "Compressor Room - Water System Operation" for instructions on adjusting the cooling water flow. If the "COOLING WATER FLOW LOW" indicator light does not extinguish, there is a problem with the cooling water system and a supervisor should be informed. Do not continue until the problem is rectified.
- \_\_\_\_\_ [6] CONFIRM that all lights on the local annunciator panel are extinguished. This means none of the safety interlocks are tripped.
- \_\_\_\_\_ [7] PRESS the skid "RESET" button (HS2361). The blue "SKID RESET" light should light or remain lit.
- \_\_\_\_\_ [8] CONFIRM that the skid's oil is reading at least 50% on LI2391E when the compressor and oil pump are not operating. If not, manually increase the oil level to approximately 50% using valve E2387M.
- \_\_\_\_\_ [9] START the oil pump using the local hand switch HS2395. Allow the oil to circulate through the cooler, filter and compressor. Check that 30 psi is established between PI2388E and PI2381H. If not, adjust E2391P. Observe the pressure loss between PI2388E and PI2398E. This should be less than 15 psi. If not, change the oil filter element. Oil level will gradually decrease while the oil pump is operating and the compressor is not.
- \_\_\_\_\_ [10] Completely UNLOAD the compressor's slide valve using the hand switch HS2378 on the local control panel. The GREEN unloaded indicator light should be lit and the visual indicator on the front face of the compressor should be in the UNLOADED position.
- \_\_\_\_\_ [11] If the compressor is not going to be started within the next 5 minutes, STOP the oil pump.
- \_\_\_\_\_ [12] RECORD in the Cryogenic Control Room Log Book that the compressor skid has been initialized.

### 5.3 Startup

This procedure is for starting up the utility compressor skid. All operations in this section can be performed either at the compressor's local control panel or by the

Cryogenic Control Computer. In the computer mode, the control room can load and unload the slide valve, start and stop the compressor and oil pump motors, and open and close the suction and discharge valves. Verify that the skid has been evacuated and purged according to Sections 5.5 and 5.6 of this OPM.

- \_\_\_\_\_ [1] CONFIRM that the compressor skid has been initialized according to sections 5.2.
- \_\_\_\_\_ [2] Mode selector switch HS2399 must be in the "LOCAL" position to operate the compressor from the local control panel. The switch must be in the "COMPUTER" position to operate the compressor from the main control room.
- \_\_\_\_\_ [3] START the oil pump. Allow the oil pump to run for 1 minute prior to starting the compressor.
- \_\_\_\_\_ [4] UNLOAD the compressor's slide valve until it is at the "UNLOADED" limit. The compressor will not start unless the slide valve is in the fully unloaded position.
- \_\_\_\_\_ [5] OPEN the main process inlet and outlet valves H2375A and H2376A.
- \_\_\_\_\_ [6] START the compressor. Once the compressor is started a restart lock-out is activated. This lock-out keeps it from being restarted for 1 hour.
- \_\_\_\_\_ [7] After 1 minute of normal operation, the slide valve can be LOADED as required.

**Note:**

The compressor can be switched from local to computer controlled mode and visa versa at any time. Switching modes will not change the state of any of the components on the skid. The Cryogenic Control Room shall be informed prior to changing the compressor skids control mode.

#### 5.4 Shutdown

This procedure is for shutting down a compressor skid after a period of normal operation. All operations in this section can be performed either at the compressor's local control panel or by the Cryogenic Control Computer.

- \_\_\_\_\_ [1] NOTIFY the Shift Supervisor that a compressor is going to be shutdown.
- \_\_\_\_\_ [2] Mode selector switch HS2399 must be in the "LOCAL" position to operate the compressor from the local control panel. The switch must be

in the "COMPUTER" position to operate the compressor from the main control room.

- \_\_\_\_\_ [3] Completely UNLOAD the compressor's slide valve.
- \_\_\_\_\_ [4] STOP the compressor.
- \_\_\_\_\_ [5] After 1 minute, STOP the oil pump.
- \_\_\_\_\_ [6] CLOSE the main process inlet and outlet valves H2375A and H2376A.
- \_\_\_\_\_ [7] RECORD in the Cryogenic Control Room Log Book that the compressor skid has been shut down.

### 5.5 Evacuation

This procedure is for evacuating and backfilling the utility compressor skid. It should be performed anytime the skid internals have been exposed to the atmosphere.

- \_\_\_\_\_ [1] Switch hand switch HS2399 into the "LOCAL" position.
- \_\_\_\_\_ [2] CONFIRM that the following valves are CLOSED; H2375A, N2366M and N2369M.
- \_\_\_\_\_ [3] CLOSE valves E2383M, E2395M, H3010M, and H3044A.
- \_\_\_\_\_ [4] OPEN valves N2370M, H2360A, and H2376A. Valve H2360A can be opened by setting PIC2360 to 0 atm.
- \_\_\_\_\_ [5] OPEN the evacuation header valve V2389M and EVACUATE the skid to approximately 500 microns as measured at the vacuum skid.
- \_\_\_\_\_ [6] CLOSE the evacuation header valve V2389M.
- \_\_\_\_\_ [7] Using the purge return header valve H3044A, slowly BACKFILL the helium lines to 30 psi.
- \_\_\_\_\_ [8] REPEAT steps 5 through 7 for two more evacuate/backfill cycles.
- \_\_\_\_\_ [9] OPEN valves E2383M and E2395M.
- \_\_\_\_\_ [10] CLOSE valves N2370M, H2360A, and H2376A. Valve H2360A can be closed by setting PIC 2360 to its normal setpoint.

- \_\_\_\_\_ [11] RECORD in the Cryogenic Control Room Log Book that the compressor skid has been evacuated and backfilled.

## 5.6 Purge

Before operating on line, a compressor skid must be purged to remove impurities from the skid internals. This procedure utilizes the utility compressor and the cryogenic purifier to clean up the gas within the skid, purifier, and interconnecting piping. The skid must be initialized and evacuated according to sections 5.2 and 5.5 of this OPM prior to performing this purge.

- \_\_\_\_\_ [1] If the carbon bed has been exposed to atmospheric air, it must be regenerated before purging the skid. See Section 5.7 of this OPM for regeneration procedures.
- \_\_\_\_\_ [2] Switch hand switch HS2399 into the "LOCAL" position.
- \_\_\_\_\_ [3] Configure the valves of the gas management system according to [C-A-OPM-ATT 7.1.9.a “Valve Configuration for Utility Compressor Purge”](#).
- \_\_\_\_\_ [4] OPEN the main process inlet and outlet valves H2375A and H2376A.
- \_\_\_\_\_ [5] START the compressor according to Section 5.3.
- \_\_\_\_\_ [6] Maintain purge supply and return pressures using the purifier controls.
- \_\_\_\_\_ [7] RUN the purifier in this mode until the gas at the purifier reaches an acceptable level of purity.
- \_\_\_\_\_ [8] STOP the compressor according to Section 5.4.
- \_\_\_\_\_ [9] CLOSE the main process inlet and outlet valves H2375A and H2376A.
- \_\_\_\_\_ [10] Return the gas management valves listed on in [C-A-OPM-ATT 7.1.9.a, “Valve Configuration for Utility Compressor Purge”](#), back to their normal positions.
- \_\_\_\_\_ [11] RECORD in the Cryogenic Control Room Log Book that the compressor skid has been purged.

## 5.7 Regenerating the Carbon Bed

Prior to operation with clean dry helium, the carbon absorber should be regenerated to prevent moisture contamination of the helium. Verify that the instrument gas systems is operating normally.

- \_\_\_\_\_ [1] CONFIRM that the compressor skid has been initialized and evacuated according to Sections 5.2 and 5.5.
- \_\_\_\_\_ [2] Switch hand switch HS2399 into the "LOCAL" position.
- \_\_\_\_\_ [3] CONFIRM that valves H2375A, H2394M and V2389M are CLOSED.
- \_\_\_\_\_ [4] CLOSE valve H2360A by setting PIC2360 to 10 atm.
- \_\_\_\_\_ [5] OPEN valves N2369M, N2370M, and N2366M.
- \_\_\_\_\_ [6] Turn ON heater HTR2360 using hand switch HS2356.
- \_\_\_\_\_ [7] Adjust N2361A to obtain 110°C at TI2360.
- \_\_\_\_\_ [8] MAINTAIN flow until TI2378 reaches 100°C.
- \_\_\_\_\_ [9] Shut OFF heater HTR2360 using hand switch HS2356.
- \_\_\_\_\_ [10] CLOSE valves N2369M, N2370M, and N2366M when the temperature at TI2378 reaches ambient.
- \_\_\_\_\_ [11] EVACUATE the carbon absorber to 500 microns using valve V2389M and the vacuum header.
- \_\_\_\_\_ [12] Slowly OPEN valve H2394M.
- \_\_\_\_\_ [13] Set PIC2360 back to its normal setpoint.
- \_\_\_\_\_ [14] RECORD in the Cryogenic Control Room Log Book that the compressor skid has had its carbon bed regenerated.

## 5.8 Configuring for Main Process Service

The utility compressor may be operated in parallel with the main compressors to provide additional flow. This section describes the valve settings of the utility compressor and gas management system necessary to achieve that operation. Verify that the compressor skid has been initialized, evacuated, and purged



according to sections 5.2, 5.5, and 5.6 of this OPM prior to performing this section.

- \_\_\_\_\_ [1] CONFIGURE the valves of the gas management system according to the Valve Configuration for Utility Compressor Used in Main Process Service settings in [C-A-OPM 7.1.9.a](#).
- \_\_\_\_\_ [2] Set PIC 2360 to 17.5 atm.
- \_\_\_\_\_ [3] Start the compressor according to section 5.3, as required.
- \_\_\_\_\_ [4] RECORD in the Cryogenic Control Room Log Book that the compressor is configured for main process service.

#### 5.9 Configuring for Purging with Cryogenic Purifier

The utility compressor may be used in conjunction with the cryogenic purifier for purging the various portions of the system. Detailed instruction for purging the skids and the gas management system are contained in the OPM's for those subsystems. This section describes the valve settings of the utility compressor and gas management system necessary to achieve that operation. Verify that the compressor skid has been initialized, evacuated, and purged according to sections 5.2, 5.5, and 5.6 of this OPM prior to performing this section.

- \_\_\_\_\_ [1] CONFIGURE the valves of the gas management system according to the Valve Configuration for Utility Compressor Used for Purging in Conjunction with the Cryogenic Purifier settings in [C-A-OPM-ATT 7.1.9.a](#).
- \_\_\_\_\_ [2] SET H3044A at 1 atm to maintain the proper suction pressure at the utility compressor.
- \_\_\_\_\_ [3] SET H3045A initially at 5 atm.
- \_\_\_\_\_ [4] Start the compressor in according to section 5.3 of this OPM.
- \_\_\_\_\_ [5] Adjust the flow through the purifier to maintain a constant pressure within the system by raising the setpoint of PIC 2360 above the setpoint of PIC3045A. All the flow will now be directed through the purifier and purge supply and return manifolds. Supply and return pressures are controlled by H3045A and H3044A and the volume in the purge piping. As components to be purged are added to or taken away from the operational volume, the supply and return pressures will change and helium must be added to or taken away to maintain pressures. The purifier and utility compressor are designed to operate between 5 and

17.5 atm and, as long as they operate within this range during purging, no changes are required.

- \_\_\_\_\_ [6] RECORD in the Cryogenic Control Room Log Book that the compressor is configured for purging with cryogenic purifier.

#### 5.10 Configuring for Gas Transfer Service

The utility compressor may used to transfer helium from the buffer tanks to gas storage. This section describes the valve settings of the utility compressor and gas management system necessary to achieve that operation. Verify that the compressor skid has been initialized, evacuated, and purged according to sections 5.2, 5.5, and 5.6 of this OPM.

- \_\_\_\_\_ [1] CONFIGURE the valves of the gas management system according to the Valve Configuration for Utility Compressor Used for Gas Transfer Service settings in C-A-OPM 7.1.9.a
- \_\_\_\_\_ [2] Set PIC 2360 to 17.5 atm.
- \_\_\_\_\_ [3] Start the compressor in according to section 5.3 of this OPM.
- \_\_\_\_\_ [4] RECORD in the Cryogenic Control Room Log Bookm that the compressor is configured for gas transfer service.

#### 5.11 Equipment Protective Interlocks

The following is a list of interlocks which will stop the utility compressors from operating or limit the operator from operating the system incorrectly.

##### 5.11.1 Gas Management Panel Master Shut Down

This interlock will shut down every compressor and pump motor in the RHIC compressor room. When activated, every compressor will stop and all the blue "SKID RESET" lights will extinguish. Operators shall immediately notify the shift supervisor when this interlock is activated.

##### 5.11.2 Differential Oil Pressure Low

This interlock activates if the differential pressure on DPSI2388E is less than 30 psi. When activated, the utility compressor will not run. When activated the Operator shall do the following:

**Note:**

This interlock will not activate for 1 minute after the oil pump has been started. this is to give the oil system a short time to balance.

- \_\_\_\_\_ [1] CONFIRM that the bulk oil separator has the proper amount of oil in it. If not, manually increase the oil level to using valve E2387M.
- \_\_\_\_\_ [2] RESTART the oil pump. Allow the oil to circulate through the cooler, filter and compressor. Check that 30 psi is established between PI 2388E and PI2381H. If not, adjust E2391P. Observe the pressure loss between PI2388E and PI2398E. This should be less than 15 psi. If not, change the oil filter element. Oil level will gradually decrease while the oil pump is operating and the compressor is not.
- \_\_\_\_\_ [3] If neither step 1 and 2 will remedy the problem, the Operator shall inform the Shift Supervisor.

#### 5.11.3 Motor Winding or Bearing Temperature High

This interlock activates if the temperature in the compressor motors windings or bearings is over set limits. When activated, the utility compressor will not run. The Operator shall inform the Shift Supervisor if this interlock activates. Under no circumstances shall the operator try to restart a compressor which trips off on this interlock without the Shift Supervisor's approval.

#### 5.11.4 Bulk Oil Separator Level High

This interlock activates if the oil level in the bulk oil separator is over set limits. When activated, the utility compressor will not run. The Operator shall notify the Shift Supervisor if the compressors trips off on this interlock.

**Note:**

When first started, the compressor will run for 9 minutes with this interlock activated. This is to allow the compressors to discharge oil out of the separator and hence lower the level.

#### 5.11.5 Bulk Oil Separator Level Low

This interlock activates if the oil level in the bulk oil separator is under set limits. When activated, the utility compressor will not run.

- \_\_\_\_\_ [1] CONFIRM that the bulk oil separator has the proper amount of oil in it. If not, manually increase the oil level to using valve E2387M.
- \_\_\_\_\_ [2] CONFIRM that the oil make-up system is running properly
- \_\_\_\_\_ [3] If neither step 1 and 2 will remedy the problem, the Operator shall inform the Shift Supervisor.

#### 5.11.6 Suction Pressure Low

This interlock activates if the compressor's suction pressure is under set limits. When activated, the utility compressor will not run. The Operator shall notify the Shift Supervisor if the compressors trips off on this interlock.

#### 5.11.7 Vibration High

This interlock activates if a compressor motor's vibration is excessive. When activated, the utility compressor will not run. The Operator shall notify the Shift Supervisor if the compressors trips off on this interlock. Under no circumstances shall the operator try to restart a compressor which trips off on this interlock without the Shift Supervisor's approval.

#### 5.11.8 Discharge Pressure High

This interlock activates if the compressor's discharge pressure is over set limits. When activated, the utility compressor will not run. The Operator shall notify the Shift Supervisor if the compressors trips off on this interlock.

#### 5.11.9 Discharge Temperature High

This interlock activates if the compressor's discharge temperature is over set limits. When activated, the utility compressor will not run. The Operator shall notify the Shift Supervisor if the compressors trips off on this interlock.

#### 5.11.10 Restart Lockout

Each compressor has its own Restart Lockout. Starting a compressor will initiate a restart lockout, which will prevent restarting the motor in the event of a shutdown for a period of 60 minutes.

#### 5.11.11 Valve Configuration Interlock

Besides the interlocks on the local skid annunciator panel, the compressors will not start unless either of the following conditions are met:

- \_\_\_\_\_ [1] Both of the skid's main process inlet and outlet valves (H2375M and H2376A) must be OPEN and the compressors slide valve must be in the fully UNLOADED position.

### 6. **Documentation**

- 6.1 The check-off lines on the procedure are for place-keeping only. The procedure is not to be initialed or signed, it is not a record.
- 6.2 The Shift Supervisor shall document the completion of the procedure in the Cryogenics Control Room Log

### 7. **Reference**

- 7.1 Drawing 3A995021, Utility Compressor P&ID.
- 7.2 BNL Compressor Station Operating Manual Volume I as supplied by Koch Process Systems Inc.
- 7.3 [C-A-OPM 7.1.5](#) “ Compressor Room- Water System Operation”.

### 8. **Attachments**

- 8.1 [C-A-OPM-ATT 7.1.9.a “ Valve Configuration for Utility Compressor Purge”](#).